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Final Report

# INTERFACING TAPAS WITH IAMS FOR LAND MANAGEMENT NEEDS

(Forest Service Research Agreement No. 28-K3-292)

Prepared for

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November 30, 1984

Air Resource Specialists, Inc.

Environmental Consultants
Air Quality, Monitoring,
Modeling, & Analysis

Fort Collins, Colorado

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# 1.0 INTRODUCTION

In recent years, the U.S. Forest Forest (USFS) and Bureau of Land Management (BLM) have conducted air resource technology research, including the development of a computer-based air quality analysis system. The Topographic Air Pollution Analysis System (TAPAS) was designed to meet the air resource management needs of the Federal Land Manager (Childs and Marlatt, 1981; Air Resource Specialists, Inc., 1984).

The overall objective of this study (Agreement No. 28-K3-292) was to investigate two potential enhancements of TAPAS that would better support air resource management application of TAPAS. The two enhancement objectives were:

(1) Assess the feasibility of integrating TAPAS into the BLM Initial Attack Management System (IAMS); and

(2) Modify, implement and test the VALMET model for potential implementation within TAPAS.

Assessing the feasibility of integrating TAPAS into IAMS was the primary emphasis of this contract effort. To date, TAPAS has been implemented on the Colorado State University Computer Center's CDC Cyber computers. The system was developed to be user friendly by extensively using interactive front-ends to prepare data files and execute programs. The bulk of the modeling programs, however, run in a batch mode for cost effectiveness. TAPAS program outputs include: 1) printed listings of generated matrices; 2) binary data files that are acceptable as input to other programs in the system; and 3) quality graphics.

Although BLM users of TAPAS can access the CSU version of TAPAS, the logistics of obtaining user accounts, computer terminals, telephone lines, and running programs and reviewing output from remote locations are often difficult. An agency-wide ability to directly access TAPAS may provide operational advantages. The BLM is currently supporting the development of the Initial Attack Management System (IAMS), a computer system based on Data General hardware and designed to support real-time fire management decisions. Integration of TAPAS into IAMS could provide the land manager with direct access to air resource-related software.

In addition, TAPAS has been designed as a flexible system so that new models and routines can be easily integrated into the system, thus providing land managers with the most up-to-date and appropriate modeling tools. The secondary objective of this study was to modify, implement, and test the VALMET model for potential implementation within TAPAS. VALMET is a model designed to simulate potential air quality impacts from pollution sources in confined valleys.

The details of all aspects of the study are included in this final report.

## 2.0 ASSESS THE FEASIBILITY OF INTEGRATING TAPAS INTO THE BLM INITIAL ATTACK MANAGEMENT SYSTEM (IAMS)

A meeting among Forest Service, Bureau of Land Management (Wyoming Office, Colorado Office, and IAMS staff) and Air Resource Specialists, Inc. personnel was held on February 9, 1984 to discuss the potential for implementing TAPAS as a component of the BLM Initial Attack Management System (IAMS). A diagram of the proposed IAMS system is provided as Figure 2-1.

Two alternatives for implementing TAPAS on IAMS were discussed:

(1) Install TAPAS on the MV4000/MV10000 computers using the Model-20 field unit as an access and display device; and

(2) Install primary portions of TAPAS directly on the Model-20 field unit.

To address these options three study tasks were defined:

(1) Assess the feasibility of converting TAPAS software from CDC Fortran 4 to DG Fortran 77;

(2) Assess the feasibility of implementing TAPAS modules on MV4000 or MV10000 computers; and

(3) Assess the feasibility of implementing TAPAS modules on the DG Model-20 computer.

Only individual computer components of the proposed IAMS system were evaluated; however, the results of these study tasks may provide a basis for designing a final approach for implementing TAPAS or IAMS.

### 2.1 Assess the Feasibility of Converting TAPAS Software from CDC Fortran 4 to DG Fortran 77

The implementation of any portion of TAPAS or IAMS will require conversion of the CDC Cyber Fortran 4 code to Fortran 77 code compatible with Data General (DG) computers (AOS and AOS/VS operating systems). Since the IAMS computer system was not yet fully implemented or

BLM INITIAL ATTACK MANAGEMENT SYSTEM'S CENTRAL COMPUTER SYSTEM

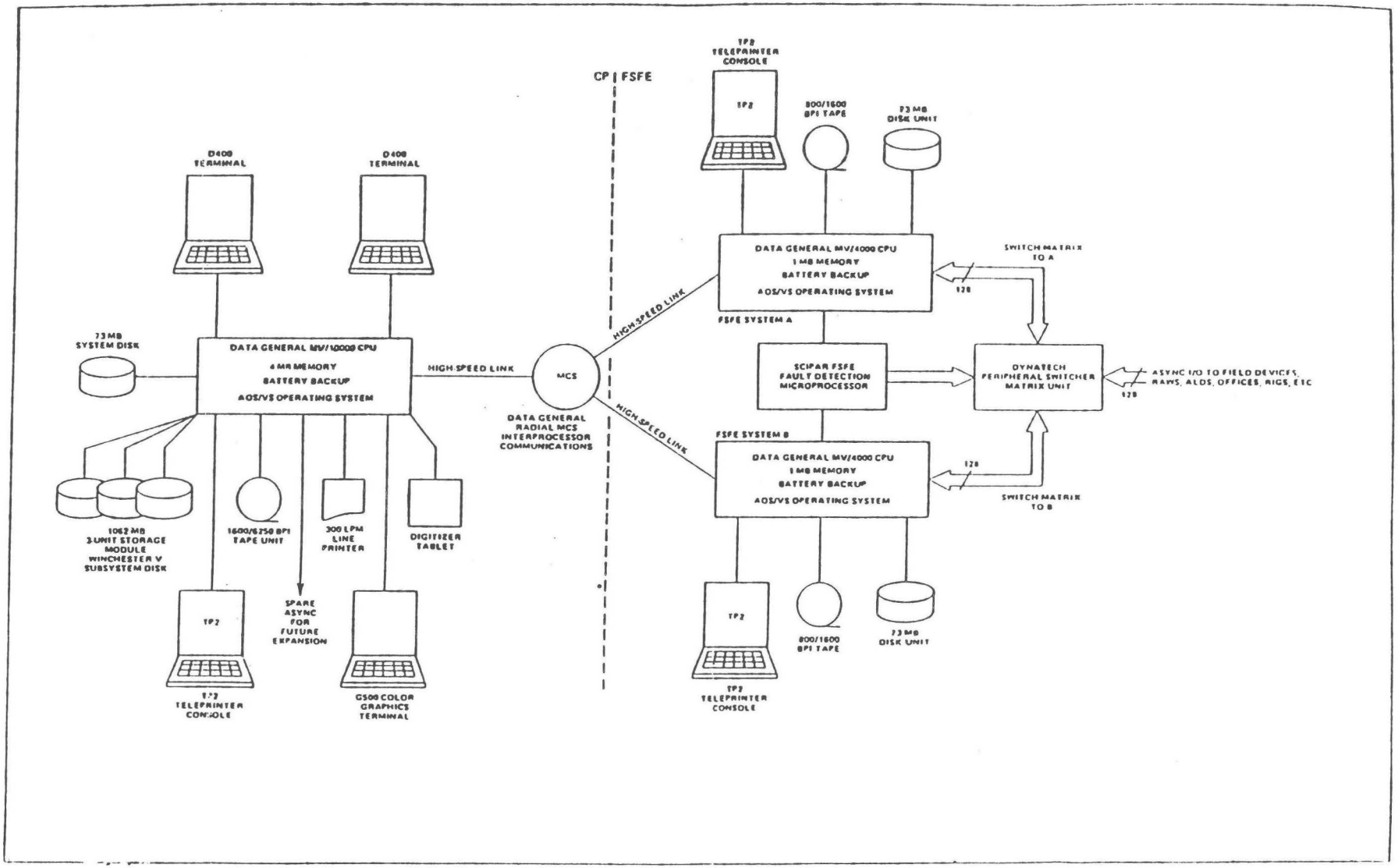


Figure 2-1. Proposed Initial Attack Management System (IAMS) Central Computer Facility Configuration.

accessible to external users, a computer time-share/lease agreement was established with Technicolor Government Services, Inc. to obtain access to a Data General MV4000 microcomputer (AOS/VS operating system, revision 1.4) to support the code conversion. The MV4000 and other hardware and software provided by Technicolor Government Services supported efficient conversion of the selected TAPAS code.

The portion of the TAPAS code selected for conversion is outlined in Figure 2-2.

The specific programs selected included:

- File Management Module (program to be fully converted and tested)

  CREATEC
  ROWCOLC
  Utility Routines

- Two-Dimensional Wind Field Simulation Module (programs to be fully converted and tested)

  WNDSETC
  WINSUPC
  WINDSC
  WINDLBC
  TAPLIBC

- Graphics Package Module (programs to be partially tested)

  NCARLB
  NCARPLT
  Tektronix Translator

File Management Module and Two-Dimensional Wind Field Simulation Module code was transferred from the CSU Cyber to the MV4000 by magnetic tape. Much of the TAPAS Cyber code is dependent upon CDC NOS 2.1 Job Control Language (JCL). This machine dependent JCL is particularly prominent in the interactive and general utility TAPAS routines. This JCL was removed from the TAPAS code and necessary utility and

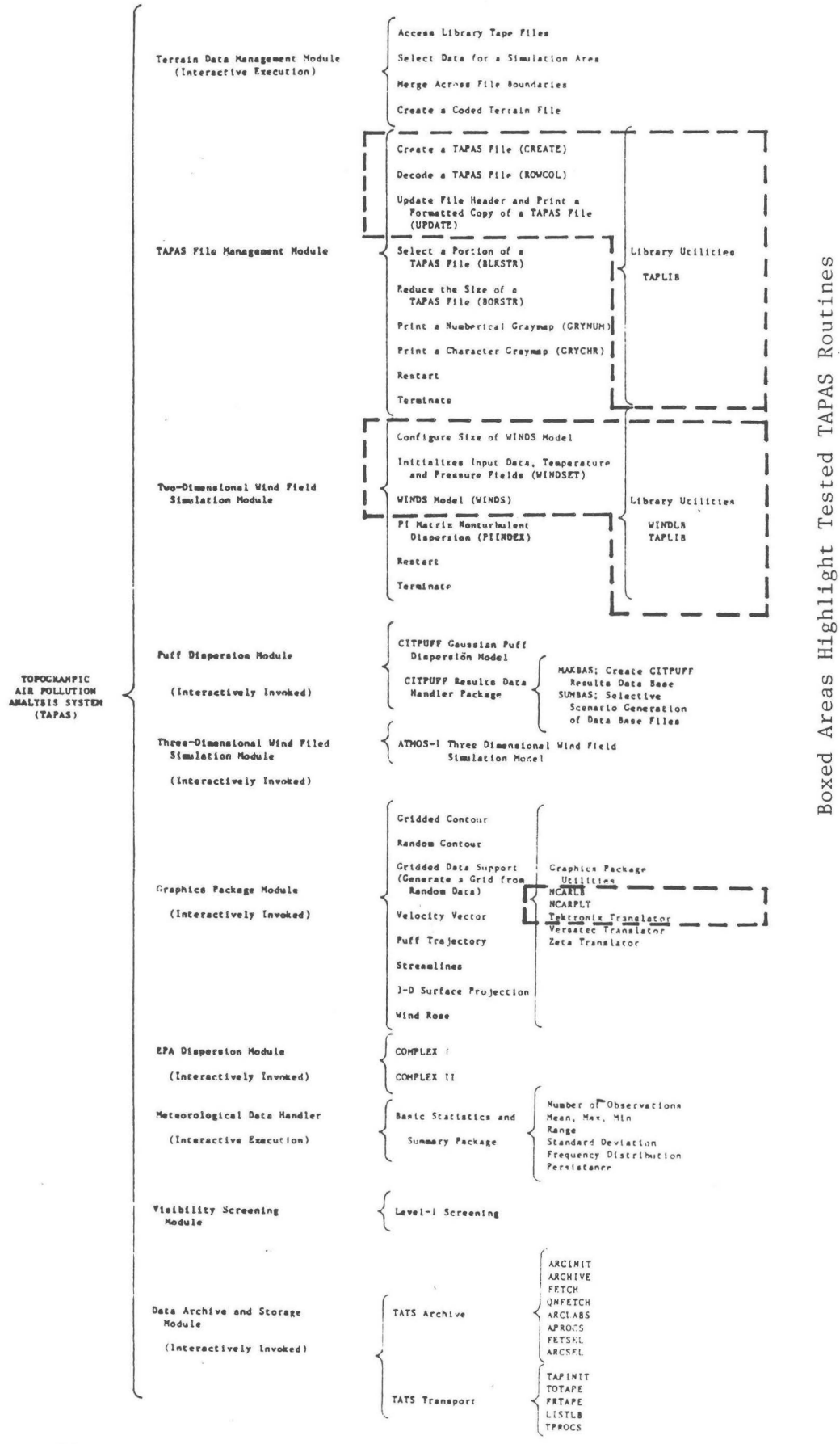


Figure 2-2. Topographic Air Pollution Analysis System with Portions Highlighted that were Chosen for IAMS Feasibility Testing.

interactive routines specific to the DG operating system were written. The remainder of the transferred code (CREATEC, ROWCOLC, WNDSETC, WINDSC, TAPLIBC, and WINDLBC) required extensive modification to accommodate the variations between CDC and DG Fortran compilers. All modifications were successfully accomplished within modest time and cost constraints. In summary, the ability to convert TAPAS software from CDC Fortran 4 to DG Fortran 77 was effectively demonstrated.

## 2.2 Assess the Feasibility of Implementing TAPAS Modules on the MV4000/MV10000 Computers

Upon completion of the preliminary code revisions, selected portions of the File Management Module and the Two-Dimensional Wind Field Simulation modules of TAPAS were tested on the MV4000. Both 20 x 20 and 100 x 100 array size data sets were tested. For example, elevation and vegetation data files were converted to TAPAS structured files and used as inputs to the WINDS model support routines and the WINDS model. The results of each run on the MV4000 were compared to benchmark runs of the same programs on the CSU Cyber. All computed values were verified and the execution time was within acceptable limits (nearly comparable to the Cyber run times).

In addition to the File Management and Two-Dimensional Wind Field Simulation modules, several programs in the graphics module were tested on the MV4000 (see Table 2) using NCAR graphics software designed for microcomputers obtained from NCAR. Example portions of the software were converted to operate on the MV4000. This software was successfully tested to demonstrate that TAPAS-related graphics could be effectively converted to Fortran 77 and implemented on the MV4000.

In summary, the MV4000 computer appears to be an effective machine to support the software conversion and was an efficient processor for the tested TAPAS modules. It can also be assumed that the MV10000, which is an extended storage version of the MV4000, would also be an efficient primary processor.

## 2.3 Assess the Feasibility of Implementing TAPAS Modules on the Data General Model-20 Computer

The Model-20 desktop computer, an integral part of the IAMS system, will be installed at every BLM field office. The ability to configure TAPAS to run directly on the Model-20 was investigated in this portion of the study.

A Model-20 and associated hardware to conduct the feasibility study was initially provided by the IAMS staff. The delivered system did not have a Fortran 77 compiler so one had to be ordered directly from the IAMS computer supply contractor. Delivery of the compiler took over six weeks. No sooner had system and software tests begun when the IAMS staff requested return of the Model-20 so that it could be installed in a field office. A computer time-share/lease agreement had to then be established with Technicolor Government Serices, Inc. to gain local access to a Model-20.

Selected portions of the TAPAS software successfully implemented on the MV4000 were chosen as the example software to be moved to the Model-20. The Model-20 uses a slightly different (but ultimately significant) operating system from the MV4000. It was learned that the Model-20 Fortran linker cannot create a program file that requires greater than 64,000 bytes of memory even though the Model-20 has up to a megabyte of storage capacity. Tests showed that only the programs

CREATEC and ROWCOLC will work under this 64k size constraint. The WINDS model, graphics routines and other TAPAS software require substantially more than 64k bytes of memory. Subsequent inquiries were made directly to Data General and to others working with the Model-20 to see if the size constraints could be resolved. No solutions were available from any group contacted. Without access to greater than 64k memory, the Model-20 would be ineffective as the primary TAPAS processor.

TAPAS programs could be broken into 64k or less segments and incrementally linked to perform analysis tasks. This method, however, would essentially require a complete recoding of TAPAS software that would be both extremely time consuming and expensive. This approach cannot be recommended. In summary, with the present configuration of the Model-20 Fortran linker, conversion of a substantial portion of TAPAS to the Model-20 is not feasible.

## 2.4 Discussion of TAPAS/IAMS Implementation Strategies

The results of the study tasks indicated that:

(1) TAPAS software could be effectively converted from CDC Fortran 4 to DG Fortran 77;

(2) The MV4000 and presumably the MV10000 computers are well suited to effectively run TAPAS modules;

(3) The Model-20 would be ineffective as a primary TAPAS processor.

This study emphasized the assessment of computer capabilities, not of the operational manpower, time, and processing volume and cost requirements of the operational IAMS. If BLM policy decisions dictate that TAPAS should be a part of IAMS, then it is recommended that TAPAS

be developed for operation on the IAMS DG MV4000/MV10000 computers. The Model-20 field units could be used as the interactive computing and graphics interface to the MV4000/MV10000 machines. To provide this interface, it will be necessary to purchase or develop effective two-way communications software for the IAMS system.

All software and software demonstrations developed in this TAPAS/IAMS analysis effort have been stored on magnetic tape and are available to the COTR upon request. Full documentation of the developed software and the creation of software user's manuals was not required or performed in this analysis effort.

## 3.0 MODIFY, IMPLEMENT AND TEST THE VALMET MODEL FOR POTENTIAL IMPLEMENTATION WITHIN TAPAS

### 3.1 Approach

The VALMET model (Whiteman and Allwine, 1983) is designed to predict air pollution concentrations in deep mountain valleys arising from nocturnal down valley transport and diffusion of an elevated plume, and the fumigation of the plume on the valley floor and sidewalls after sunrise. VALMET may be a valuable addition to TAPAS since currently no models exist within TAPAS that adequately address valley flow.

The objective of this phase of the study was to appropriately modify and test VALMET for potential implementation within TAPAS. The approach was to implement VALMET on the CSU CDC computers so that more extensive testing of VALMET could be performed by the USFS and BLM. Full incorporation of VALMET into TAPAS will occur in the future after model testing is completed.

The VALMET Fortran code received from the Pacific Northwest Laboratory was modified and implemented on the CSU CDC computer as follows:

(1) Code was modified to conform to CDC Fortran 5 standards. This modification primarily involved the input/output routines OPEN and CLOSE. CDC.Fortran 5 allows file opening within the program statement.

(2) Code was modified to conform to TAPAS philosophy of cost efficiency by allowing batch execution. This was accomplished by allowing the user to create and save a batch input file that can be modified with the CDC edit utilities. This file is then used as the parameter input file which automatically runs the program in batch mode.

(3) The plot program was modified to conform to CDC Fortran 4 standards and to run with NCAR graphics software (standard in TAPAS). The modified plot program is designed to run in batch mode in compliance with the TAPAS philosophy. Plot program outputs are compatible with CSU graphics plotters. Example model graphics are provided in Figure 3-1.

(4) A NOS Version 2.2 interactive procedure file was written to drive VALMET routines.

(5) Programs were debugged, tested and documented.

## 3.2 VALMET Model Procedure Execution

The procedures necessary to run the VALMET model and plot programs are contained in a procedure file called VALPROC. It is assumed that the user has a rudimentary knowledge of execution of CDC NOS procedures and file handling. Three procedures are found in VALPROC: VALMET, VALPLOT, and NCARV. The user need only be concerned with the first two (VALMET and VALPLOT) since the last procedure (NCARV) can only be accessed by a batch job and is used for plotting the VALMET data.

To execute a procedure, the user enters the following:

```
-PROC,PROCFILE?
```

where "PROC" is the name of the procedure you wish to run and "PROCFILE" is the name of the file containing the procedure.

### 3.2.1 VALMET Procedure Execution

The following is entered to execute the VALMET procedure:

```
-VALMET,VALPROC?
```

This will run the VALMET program. Following is a sample interactive run of the VALMET procedure which accesses and runs the VALMET program:

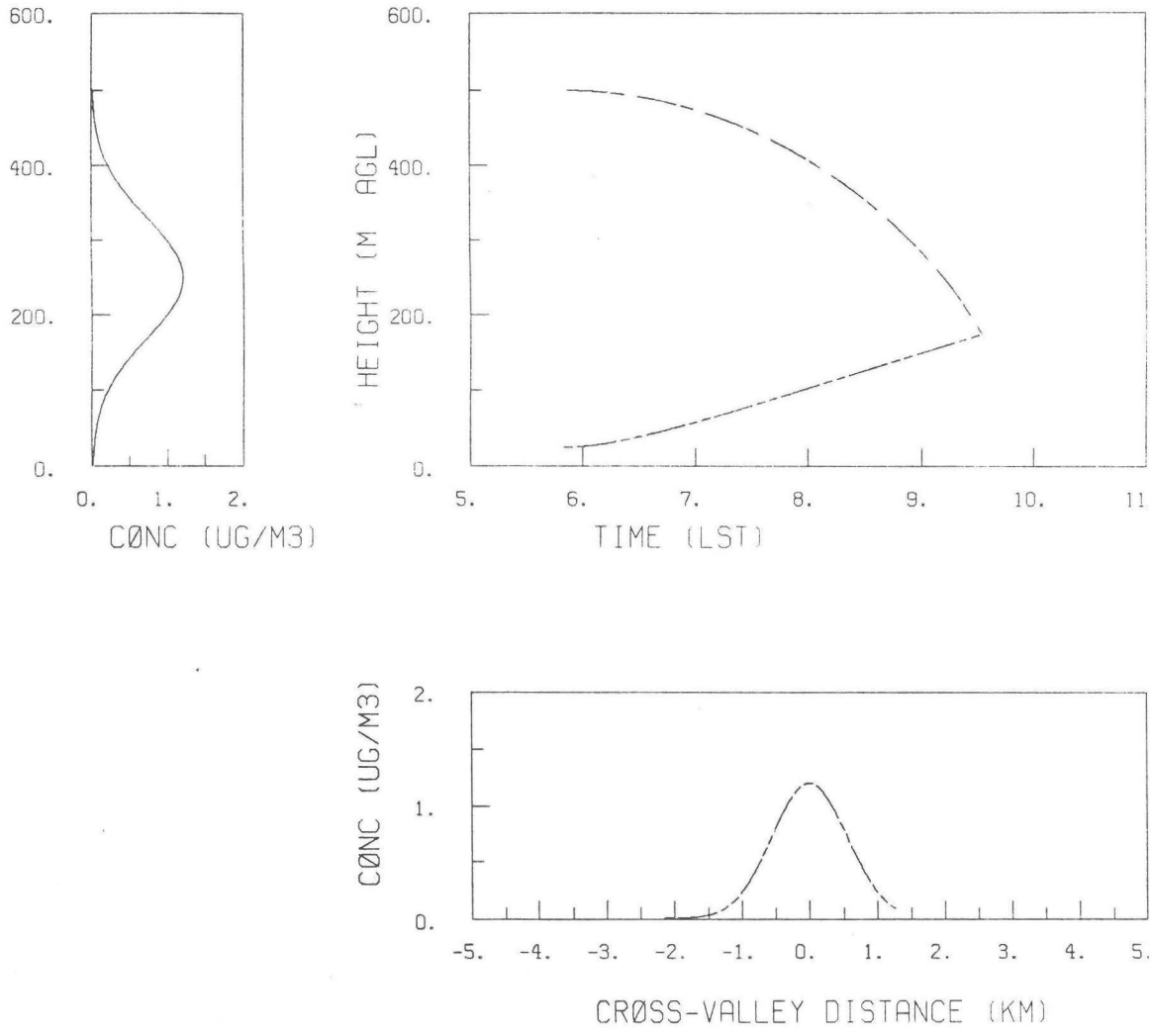


Figure 3-1. Example VALMET Plot.

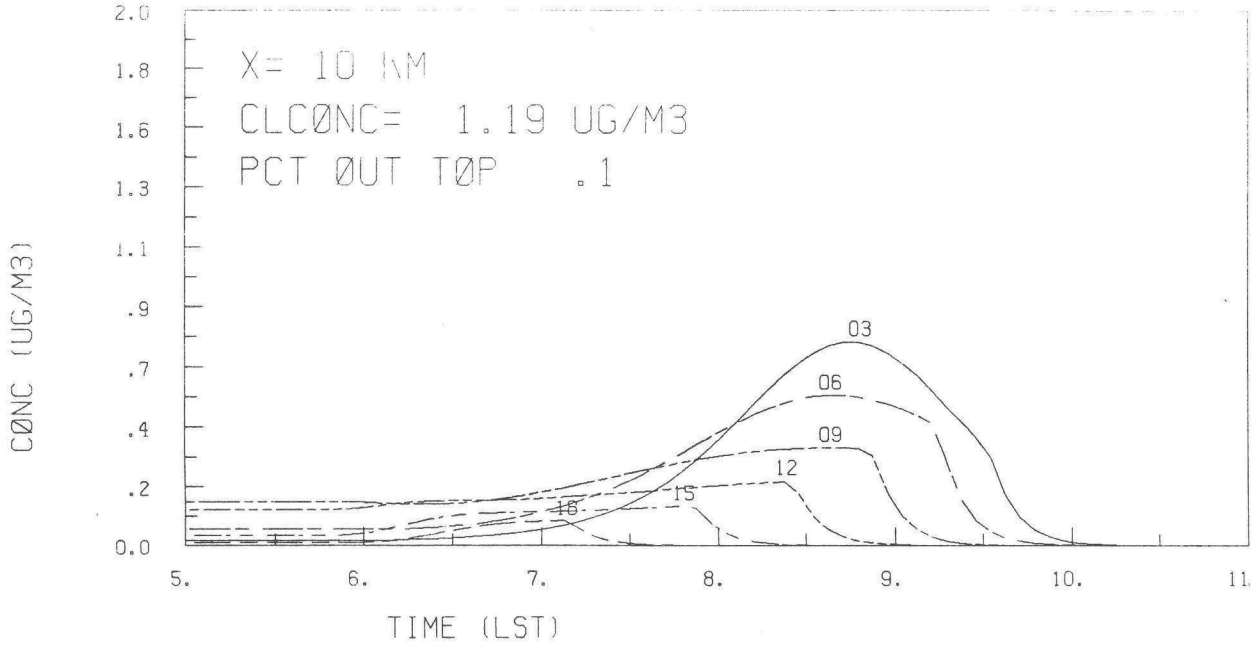


Figure 3-1. Continued

```
READY.
-valmet,valproc?

      THIS PROCEDURE EXECUTES THE VALMET MODEL.  THE PRIMARY OPTION ALLOWS
      INTERACTIVE OR BATCH EXECUTION.  IF THE FILE INPUT IS SPECIFIED FOR
      THE PARAMETER FILE, THE RUN WILL BE INTERACTIVE.  IF ANY OTHER FILE
      IS SPECIFIED, THE PROGRAM WILL BE SUBMITTED AS A BATCH JOB.  THE OTHER
      PARAMETERS REQUIRED ARE DOCUMENTED IN THE PROC PARAMETER LIST.

 ENTER THE FOLLOWING PARAMETERS (DEFAULT VALUES IN PARENTHESIS-
 TO SPECIFY THE DEFAULT, ENTER A "cr") :

    NOTE:  IF YOU WISH TO STOP EXECUTION OF THE PROCEDURE DURING
           PARAMETER ENTRY, ENTER "STOP"

 PARAMETERS FOR VALMET ARE  PARAMS, VALOUT, VALPLTF, JOBID, ID
 PARAMETER FILE (INPUT) ? input
 OUTPUT FILE (VALOUT) ? valout
 PLOT DATA FILE (VALPLTF) ? valpltf
 JOB ID (BN09DEM) ? bn09dem
 ROUTE JOB OUTPUT TO __ (00)? 00
```

At this point the VALMET program takes over and prompts the user for parameter modification and executes the program. Following is an example VALMET program run:

```
 THE PROGRAM INITIALIZATION PARAMETERS ARE SET TO THE  FOLLOWING VALUES:

 SENSIBLE HEAT FLUX    [ 1] A0    =   .24 [ 2] K      =   .15
 VALLEY CHARACTER.     [ 3] WIDTH =  600. [ 4] ALPHA1=   15. [ 5] ALPHA2=   15.
 MODEL CHARACTER.      [ 6] NBOX  =     3
 INVERSION CHARACTER.  [ 7] HZERO =  500. [ 8] GAMMA =  .025 [ 9] BETA  = 0.000
 SITE LOCATION         [10] LAT   = 40.00 [11] URLONG=105.00
 DATE                  [12] MO    =    9 [13] IDAY  =    21 [14] IYR   =    82
 VALLEY ATMOSPHERE     [15] TEMP  = 10.00 [16] PRESS =750.00
 GAUSSIAN PLUME        [17] XC    =10000. [18] YZERO =    0. [19] UC    =  4.00
                       [20] Q     = .0010 [21] STAB  =F      [22] US    =  4.00
 STACK CHARACTER.      [23] H     =250.00 [24] STMP  =100.00 [25] SRAD  =  3.00
                       [26] SVEL  = 24.00 [27] AS    =    0.

 IF NO CHANGES ARE TO BE MADE IN VALUES IN TABLE ---- ENTER 99
 IF "STAB" IS TO BE CHANGED ---- ENTER 98
 IF CHANGES OTHER THAN TO "STAB" ARE TO BE MADE --- ENTER TOT. NUMBER
 OF CHANGES
? 1

 SPECIFY ID. NUMBER OF PARAMETER TO BE CHANGED FOLLOWED BY THE NEW VALUE.
 ALL CHANGES ARE ENTERED SEPARATED BY COMMAS (E.G., 1,200.,2,50.,4,600., ETC).
? 10,42
```

```
 THE PROGRAM INITIALIZATION PARAMETERS ARE SET TO THE  FOLLOWING VALUES:

 SENSIBLE HEAT FLUX    [ 1] AO     =    .24 [ 2] K      =    .15
 VALLEY CHARACTER.     [ 3] WIDTH  =  600. [ 4] ALPHA1=    15. [ 5] ALPHA2=    15.
 MODEL CHARACTER.      [ 6] NBOX   =      3
 INVERSION CHARACTER.  [ 7] HZERO  =  500. [ 8] GAMMA  =  .025 [ 9] BETA   = 0.000
 SITE LOCATION         [10] LAT    = 42.00 [11] URLONG=105.00
 DATE                  [12] MO     =     9 [13] IDAY   =    21 [14] IYR    =     82
 VALLEY ATMOSPHERE     [15] TEMP   = 10.00 [16] PRESS  =750.00
 GAUSSIAN PLUME        [17] XC     =10000. [18] YZERO  =     0. [19] UC     =   4.00
                       [20] Q      = .0010 [21] STAB   =F       [22] US     =   4.00
 STACK CHARACTER.      [23] H      =250.00 [24] STMP   =100.00 [25] SRAD   =   3.00
                       [26] SVEL   = 24.00 [27] AS     =     0.

 IF NO CHANGES ARE TO BE MADE IN VALUES IN TABLE ---- ENTER 99
 IF "STAB" IS TO BE CHANGED ---- ENTER 98
 IF CHANGES OTHER THAN TO "STAB" ARE TO BE MADE --- ENTER TOT. NUMBER
 OF CHANGES
? 99
  DO YOU WISH TO SAVE THESE PARAMETERS IN A PERMANENT FILE ? (Y OR N) -
? y
  INPUT A 7-CHARACTER FILE NAME -
? param1
 PROGRAM PARAMETERS SAVED IN PERMANENT FILE PARAM1
 VALMET EXECUTION TO CONTINUE - PLEASE WAIT
 VALMET EXECUTION COMPLETE

LOCAL FILE VALOUT SAVED AS PERMANENT AND ROUTED TO ID=00.
READY.
```

At this point the user should examine the files VALDAY and VALOUT and determine if the job executed properly. A printout of file VALOUT should be retained for later plotting since parameters included in this output will be needed to set up the plotting parameters.

### 3.2.2 VALPLOT Procedure Execution

The following command is given to execute the VALPLOT procedure:

-VALPLOT,VALPROC?

This will prompt the user for the necessary parameters to execute the program VALPLOT, submit a batch job to execute the program and inform the user of the job number. Following is an example of an execution of VALPLOT procedure.

```
-valplot,valproc?
 THIS PROCEDURE REQUESTS PARAMETERS NEEDED TO RUN THE VALMET PLOTTING PROGRAM.
 DEFAULT VALUES ARE NOTED IN PARENTHESIS AND A "cr" WILL SELECT THE DEFAULT.
 SPECIAL CHARACTERS ('.' '-') REQUIRE THAT THE VALUE BE ENCLOSED IN '$' --
 EXAMPLE          $-4.0$    -CORRECT
                  -4.0      -INCORRECT
                    10      -CORRECT
                   600.     -INCORRECT
                   $600.$   -CORRECT

 PARAMETERS FOR VALPLOT ARE  JOBID, ID, VALPLTF, CONCMIN,
 CONCMAX, TMIN, TMAX, YMIN, YMAX, ZMIN, ZMAX, CURV1, CURV2, CURV3,
 CURV4, CURV5, CURV6, CURV7, CURV8,
 CURV9, CURV10

 ENTER A 4-7 CHARACTER JOB ID (BN09DEM) ? bn09dem
 ROUTE JOB OUTPUT TO __(00) ? 00
 VALMET PLOTTING DATA (VALPLTF) ? valpltf
 CONCENTRATION MINIMUM VALUE (0)   ? 0
 CONCENTRATION MAXIMUM VALUE (2)   ? 2
 MINIMUM TIME (0) ? 5
 MAXIMUM TIME (10)  ? 11
 CROSS-SECTION MINIMUM (-5) ? $-5$
 CROSS-SECTION MAXIMUM (+5) ? 5
 MINIMIMUM HEIGHT (0) ? 0
 MAXIMUM HEIGHT (600) ? 600
 CURVE 1 GRID LOCATION (NONE) ? 3
 CURVE 2 GRID LOCATION (NONE) ? 6
 CURVE 3 GRID LOCATION (NONE) ? 9
 CURVE 4 GRID LOCATION (NONE) ? 12
 CURVE 5 GRID LOCATION (NONE) ? 15
 CURVE 6 GRID LOCATION (NONE) ? 18
 CURVE 7 GRID LOCATION (NONE) ?
 CURVE 8 GRID LOCATION (NONE) ?
 CURVE 9 GRID LOCATION (NONE) ?
 CURVE 10 GRID LOCATION (NONE)  ?


  16.57.35. SUBMIT COMPLETE.  JSN IS PCTI.

 VALMET PLOTTING JOB SUBMITTED
 RESULTS OF THE RUN WILL BE
 IN THE FILE PLOTOUT.
 THE JOB DAYFILE SHOULD BE
 EXAMINED IN FILE PLOTDAY.

 READY.
```

## 3.3 Demonstration

The VALMET routines were demonstrated to USFS personnel D. Fox and R. Fisher on July 24, 1984. A preliminary user's guide and all software was delivered in conjunction with this demonstration.

## 4.0 SUMMARY

Two potential enhancements of TAPAS were investigated:

(1) Assess the feasibility of implementing TAPAS into the BLM Initial Attack Management System (IAMS); and

(2) Modify, implement and test the VALMET model for potential implementation within TAPAS.

The feasibility of implementing TAPAS on IAMS was investigated for two possible IAMS computer configurations: (1) using the MV4000/MV10000 computers as the primary processor; and (2) using the Model-20 field unit as the primary processor. Conversion and testing of selected WINDS model-related TAPAS programs were successfully performed on a DG MV4000 computer. The Fortran 77 compiler and linker for the DG Model-20 limits memory access to 64,000 bytes. This memory limitation restricts any substantial implementatin of TAPAS on the Model-20. It is, therefore, recommended that any further development of TAPAS for IAMS be designed for the MV4000/MV10000 configuration. The Model-20 could be effectively used as the field office interface to the MV4000/MV10000 for interactive processing and graphics display.

The VALMET model was successfully converted and demonstrated on the CSU Cyber computer. The model and associated graphics output routines were configured to match TAPAS operational standards. A preliminary user's manual and documented code were delivered to the USFS for review and further testing.

It would be technically possible to implement both of the potential TAPAS enhancements investigated in this study. Final implementation will be dependent on the policy set forth by the USFS and BLM for the operational support and further development of TAPAS.

## References

Air Resource Specialists, Inc. 1984. Final Report - Air Quality Technolgoy, Research, Development and Demonstration for Land Management Needs. USDA F.S. Research Contract No. 28-K2-257. Rocky Mountain Forest and Range Experiment Station.

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